distribution system in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

Turning initially to FIGURE 1, there is illustrated a representative portion of a message paging network 10 in accordance with one embodiment of the present invention. Message paging network 10 comprises a wireless messaging distribution system 20, a message database 25, and an RF transmitter and receiver facility 30 (hereafter, "RF transceiver 30") for sending wireless messages to a subscriber's paging device 35 and, optionally, receiving wireless response messages therefrom. Depending on the level of service for which the subscriber has paid, RF transceiver 30 may send data and/or voice messages in one direction only (i.e., to the paging device 35). Alternatively, data and/or voice signals may be communicated bidirectionally between RF transceiver 30 and paging device 35. The RF transceiver 30 may comprise a single transmitter and receiver facility or may comprise an entire infrastructure of many transmitters and receivers covering a large geographical area.

Wireless messaging distribution system 20 receives wireless messages from a variety of input sources, including a standard telephone 40 and a message generating computer 50, and transmits the wireless messages to paging device 35 via RF transceiver 30.

Information related to each wireless message is stored in message database 25 for later retrieval and viewing by the subscriber.

Wireless messages may be entered by a caller on telephone 40 by pressing the telephone keypad buttons to thereby generate DTMF tones that are interpreted by wireless messaging distribution system 20 as, for example, a telephone number that the subscriber should call in order to respond. In more sophisticated systems, combinations of DTMF tones may be interpreted as letters and numbers (i.e., alphanumeric characters) to thereby enable the caller to send alphanumeric text messages to the subscriber. In a wireless messaging system, the caller may enter voice messages that are sent to paging device 35.

Message generating computer 50 is representative of any one of a large number of processing devices that may be used to create alphanumeric text and/or voice messages that are sent to paging device 35 and, optionally, to receive response messages from paging device 35. For example, message generating computer 50 may be a standard desktop personal computer (PC), a laptop PC, a hand held processing device, such as a PalmPilot®, a two-way paging device, or the like. Message generating computer 50 may also include a dedicated paging controller embedded in a larger piece of equipment, such as an oil rig, a vending machine, or a vehicle,

that generates paging messages, particularly alarms and notifications, in order to alert a supervisor or maintenance person of a condition in the equipment.

Wireless messaging distribution system 20 also communicates with a message retrieval computer 60. Message retrieval computer 60 is also representative of any one of a large number of processing devices that may be used to retrieve and display information stored in message database 25 relating to alphanumeric text and/or voice messages that were sent to paging device 35 and, optionally, to retrieve and display information relating to response messages that were sent by paging device 35. For example, message retrieval computer 60 may be a standard desktop personal computer (PC), a laptop PC, or a hand held processing device, such as a PalmPilot®, or the like. In one embodiment of the present invention, message retrieval computer 60 comprises a desktop PC capable of operating a browser application, such as Netscape Navigator® or MicroSoft Internet Explorer®.

Wireless messaging distribution system 20 may communicate with message retrieval computer 60, telephone 40, and message generating computer 50 via the public phone system 70 or by the Internet (or a large private network) 80. At least portions of the phone system 70 or Internet (large private network) 80 may include a

wireless network. Although wireless messages may be transferred to the wireless messaging distribution system 20 by telephone 40 and message generating computer 50 through either the public phone system 70 or the Internet 80, as a practical matter, most "conventional" numeric paging messages are be received via the public phone system 70. The means by which a subscriber using message retrieval computer 60 accesses wireless messaging distribution system 20 may be selected at the subscriber's option. The subscriber may use a direct dial-in connection to wireless messaging distribution system 20 (i.e., via the public phone system 70) or may use a browser application on message retrieval computer 60 to access wireless messaging distribution system 20 via the Internet 80, or both.

In a preferred embodiment of the present invention, wireless messaging distribution system 20 is essentially a server that receives wireless messages from different clients via the public telephone system 70 and the Internet 80, forwards the messages to RF transceiver 30, and stores copies of the wireless messages in database 25. Wireless messaging distribution system 20 then allows client devices to use graphical user interfaces to selectively view and retrieve the copies of the wireless messages. After a wireless message has been retrieved, the subscriber can then issue a

response message or generate a new follow-up message(s). Once a subscriber has entered into a session with the server in wireless messaging distribution system 20 by entering a subscriber ID and a password, the subscriber can issue response messages and/or generate new follow-up messages without re-entering the subscriber ID or re-entering the address of the party to whom the subscriber wishes to send a response message.

FIGURE 2 illustrates representative subscriber data records 201-203 in message database 25 in message paging network 10 in accordance with one embodiment of the present invention. The contents of subscriber data records 201-203 vary according to the type of messaging service for which the subscriber has paid. Nonetheless, subscriber data record 201 (hereafter "Subscriber 1 Record") is representative of any one of the records for Subscriber 1 through Subscriber N. In Subscriber 1 Record, received message 210 and received message 220 have been stored in message database 25 by wireless messaging distribution system 20.

Subscriber 1 Record contains a Subscriber 1 ID and Password field that is used to access the correct subscriber data record and confirm the identity of Subscriber 1. In an exemplary embodiment, the ID of Subscriber 1 is simply the telephone number of the paging device 35 used by Subscriber 1. When a wireless message is sent

from telephone 40 or message generating computer 50 to paging device 35, a copy of the message is stored in message database 25 in a subscriber data record identified by the subscriber telephone number associated with paging device 35. During message retrieval, the subscriber enters the telephone number associated with paging device 35 to initiate access to the Subscriber 1 Record and wireless messaging distribution system 20 then requests a password from the subscriber before granting actual access. If the subscriber enters the proper password, the subscriber can retrieve and view wireless messages 210 and 220, as well as any others left for Subscriber 1.

Wireless message 210 comprises a Message ID field 211 containing the identifier "Message 1". In a preferred embodiment of the present invention, the Message ID may also include a sub-field used to indicate the message status, such as "delivered", "undelivered", "read", "unread", and the like. Wireless message 210 also comprises a Sender ID (or return address) field 212. In the example shown, wireless message distribution system 220 has used Caller ID data received from the public phone system 70 to insert in the Sender ID field 212 the telephone number (i.e., 555-1212) of the caller/message sender. In an alternate scenario, wireless message distribution system 220 may insert in

the Sender ID field 212 an e-mail address of the message sender for alphanumeric messages received from the Internet 80. In still another alternate scenario, wireless message distribution system 220 may insert in the Sender ID field 212 a pager address as the return address of the message sender. A Time Stamp field 213 in wireless message 210 contains the time at which the caller left wireless message record 210.

Wireless message 210 further comprises an Attachment Type & Size field 214. In a preferred embodiment of the present invention, a caller/message sender using message generating computer 50 may attach a document, such as a WordPerfect document or an MS Word document to a wireless message sent to paging device 35. A value of zero, for example, may be inserted in the Attachment Type & Size field 214 to indicate that there is no attachment. A non-zero value in the Attachment Type & Size field 214 may be used to indicate to the subscriber that there is an attachment associated with wireless message record 210 and further, what type of file the attachment is (i.e., text document, voice message file, or the like). Advantageously, this allows the subscriber to determine what the attachment is before requesting that the attachment be downloaded to, for example, the message retrieval computer 60.

A Message Text field 215 in wireless message 210 stores the contents of the actual wireless message sent to the paging device 35. In the example shown, the caller has entered his own telephone number (i.e., 555-1212) on, for example, the button keypad of telephone 40. An Acknowledgment Message field 216 holds a response message, if any, received from paging device 35 acknowledging receipt of wireless message 210 by paging device 35. Finally, Attachment Text field 217 holds the contents of any attached document identified in the Attachment Type field 214.

Likewise, wireless message 220 stored in message database 225 comprises a Message ID field 221, a Sender ID field 222, a Time Stamp 223, an Attachment Type field 224, a Message Text field 225, an Acknowledgment Message field 226, and an Attachment Text field 227. Whereas wireless message record 210 consists of a simple telephone number message page entered by a caller using the telephone keypad buttons of telephone 40, wireless message record 220 is a more complex message that consists of an alphanumeric message and an attachment sent by a caller using message generating computer 50.

The Message ID field 212 in wireless message 220 contains the identifier "Message 2". In the example shown, wireless message distribution system 220 has inserted the name ("Joe Smith") of the

message sender in the Sender ID field 222. Wireless message distribution system 220 may obtain the message sender's name using Caller ID data received from the public phone system 70. Alternatively, the message sender may directly enter his or her own name, or the message sender's name may be extracted from the header data of an e-mail. One again, a Time Stamp field 223 in wireless message 210 contains the time at which the caller left wireless message record 220.

The Attachment Type field 224 in wireless message 220 indicates that an attachment is associated with wireless message 220 and indicates that it is a text document. The Message Text field 225 in wireless message 220 stores the contents of the actual wireless message sent to the paging device 35. In the case the wireless message states, "Meeting postponed until 4:30 PM. New agenda attached." As before, the Acknowledgment Message field 226 holds a response message, if any, received from paging device 35 acknowledging receipt of wireless message 220 by paging device 35. Finally, Attachment Text field 227 holds the contents of the attached document identified in the Attachment Type field 224, which in this case is an agenda document.

FIGURE 3 illustrates an exemplary wireless messaging distribution system 20 according to one embodiment of the present

invention. Wireless messaging distribution system 20 in the exemplary embodiment is a server that handles incoming wireless messages intended for paging device 35, and also handles message retrieval requests received from subscribers attempting to review stored wireless messages. Wireless messaging distribution system 20 comprises a message retrieval controller 250, an incoming message controller 255, and an associated memory 260 shared by both controllers.

Message retrieval controller 250 and incoming message controller 255 are coupled by a common bus to Internet and phone system I/O interface 265, which bi-directionally transfers data to and from public phone system 70 and Internet 80. Incoming wireless messages are directed by Internet and phone system I/O interface 265 to incoming message controller 255. Message retrieval requests are similarly directed to message retrieval controller 250 by Internet and phone system I/O interface 265. Internet and phone system I/O interface 265 may distinguish between incoming wireless messages and incoming message retrieval requests according to the received Internet address or the telephone number to which the incoming call is directed.

Message retrieval controller 250 and incoming message controller 255 are also connected by means of a common bus to

message database I/O interface 270 and RF I/O interface 275. Message database I/O interface 270 stores and retrieves subscriber data records to and from message database 25. RF I/O interface 275 transfers incoming wireless messages to RF transceiver 30 and, in the case or two-way messaging systems, receives wireless messages from RF transceiver 30. The methods by which incoming message controller 255 handles incoming wireless messages are described below in greater detail in connection with FIGURE 4. The methods by which message retrieval controller 250 handles incoming message retrieval requests are described below in greater detail in connection with FIGURE 5.

FIGURE 4 is a flow diagram 300 illustrating a wireless message receipt and forwarding operation of a representative wireless messaging distribution system in accordance with one embodiment of the present invention. Initially, wireless messaging distribution system 20 receives an incoming connection request from a wireless message sender from either public phone system 70 or Internet 80 (method step 305). Next, wireless messaging distribution system 20 receives the contents of the wireless message itself and determines therefrom the recipient subscriber to whom the wireless message must be transmitted via RF transceiver 30 (method step 310).

Wireless messaging distribution system 20 compares the incoming wireless message type with the service for which the recipient subscriber (hereafter "Subscriber X") has subscribed (method step 315). This step insures that the sender does not attempt to send an incompatible message type to paging device 35, such as, for example, sending a voice message to an alphanumeric paging device. If the incoming message type is incompatible with the service of Subscriber X, or cannot be converted to a compatible type by the system, wireless messaging distribution system 20 rejects the wireless message and returns to the initial state of waiting for the next connection request from a sender (method steps 320 and 305). If the message type is compatible with the service of Subscriber X, or can be converted by the system, wireless messaging distribution system 20 forwards the wireless message to RF transceiver 30 for transmission to paging device 35 (method steps 320 and 330).

Wireless messaging distribution system 20 then stores a copy of the wireless message in the data record of Subscriber X in message database 25 (method step 335). Finally, if paging device 35 used by Subscriber X is capable of generating response messages (as in a two-way messaging system), wireless messaging distribution system 20 stores a copy of the wireless response

message received from paging device 35 in the data record of Subscriber X in message database 25 (method step 340).

FIGURE 5 is a flow diagram 400 illustrating a wireless message retrieval operation of a representative wireless messaging distribution system in accordance with one embodiment of the present invention. Initially, wireless messaging distribution system 20 receives a connection request from Subscriber X, who is attempting to retrieve and display stored wireless messages (method step 405). Before allowing this transaction, wireless messaging distribution system 20 authenticates the identity of Subscriber X by requesting that Subscriber X enter a Subscriber ID and a corresponding password (method step 410). If the password entered by Subscriber X does not match the stored password, wireless messaging distribution system 20 rejects the connection request from Subscriber X (method steps 415 and 420). If the password entered by Subscriber X matches the stored password for Subscriber X data record in message database 25, wireless messaging distribution system 20 retrieves the data record of Subscriber X from message database 25 (method steps 415 and 425).

Next, wireless messaging distribution system 20 sends selected fields of the stored wireless messages to message retrieval computer 60 used by Subscriber X (method step 430). By sending

only selected portions of the stored wireless messages, rather than the entirety of the stored wireless messages, wireless messaging distribution system 20 allows Subscriber X to review the truncated/abbreviated information before requesting that all of one or more wireless messages be downloaded to message retrieval computer 60. This advantageously conserves bandwidth between wireless messaging distribution system 20 and message retrieval computer 60 and prevents the undesirable downloading of unexpectedly large attached documents to Subscriber X without first warning of the size of the attached document.

After Subscriber X has reviewed the selected wireless message information displayed on message retrieval computer 60, wireless messaging distribution system 20 may receive selected requests from Subscriber X to download complete wireless messages from message database 25 to message retrieval computer 60 (method step 435). Upon receiving such a complete message retrieval request, wireless messaging distribution system 20 sends corresponding complete wireless messages and response/follow-up messages, if any, to message retrieval computer 60 (method step 440).

Finally, wireless messaging distribution system 20 may receive from Subscriber X one or more response/follow-up messages corresponding to one or more of the complete wireless messages and

response/follow-up messages that were downloaded to message retrieval computer 60 (method step 445). Wireless messaging distribution system 20 may then forward the response/follow-up message(s) to the sender(s) of the original wireless message(s) sent to Subscriber X (method step 450).

In a preferred embodiment of the present invention, accessing a message through message retrieval computer 60 before the message has been delivered by RF transmission to a pager may cause the cancellation of the RF transmission if the subscriber chooses that option. For example, if a subscriber has traveled outside of the subscriber's coverage area (or has turned the pager "OFF"), the subscriber may nonetheless use message retrieval computer 60 to retrieve a message that has not been delivered to the pager. When the subscriber returns to the subscriber's coverage area (or turns the pager "ON" again), RF transceiver 30 will transmit what is now a redundant message to the subscriber. To prevent this from happening, the subscriber may select a system option that cancels the subsequent RF transmission of any currently undelivered message if the undelivered message is first retrieved by message retrieval computer 60.

Although the principles of the present invention have been described in detail with reference to message paging system and

infrastructure embodiments, those of ordinary skill in the art should understand that they can make various changes, substitutions and alterations herein without departing from the spirit and scope of the invention in its broadest form.

WHAT IS CLAIMED IS:

1. For use in a wireless messaging system, a message distribution system capable of allowing a subscriber of said wireless messaging system to review stored wireless messages sent to said subscriber comprising:

a first I/O interface capable of receiving a message retrieval request from said subscriber;

a message retrieval controller coupled to said first I/O interface capable of determining an identity of said subscriber from identification data contained in said message retrieval request, retrieving a data record associated with said subscriber, said data record containing one or more of said stored wireless messages, and transferring to said subscriber one or more selected portions of at least one of said stored wireless messages.

2. The message distribution system set forth in Claim 1 further comprising a database coupled to said message distribution system capable of storing said stored wireless messages.

3. The message distribution system set forth in Claim 1 wherein said message distribution system requires said subscriber to enter a password prior to transferring to said subscriber said one or more selected portions of said at least one of said stored wireless messages.

4. The message distribution system set forth in Claim 1 wherein said first I/O interface is capable of receiving a wireless message directed to said subscriber.

5. The message distribution system set forth in Claim 4 further comprising a second I/O interface capable of sending said received wireless message to an RF transceiver facility operable to transmit said received wireless message to a paging device of said subscriber.

6. The message distribution system set forth in Claim 4 further comprising an incoming wireless message controller capable of determining an identity of said subscriber from identification data contained in said received wireless message.

7. The message distribution system set forth in Claim 5 wherein said message distribution system is capable of receiving from said RF transceiver facility a response message responsive to a transmission of said received wireless message to said paging device.

8. The message distribution system set forth in Claim 1 wherein said message retrieval request is received from a public telephone system.

9. The message distribution system set forth in Claim 1 wherein said message retrieval request is received from a wide area data network.

10. A wireless messaging system comprising:

a plurality of RF transceiver facilities capable of transmitting and receiving wireless messages to and from paging devices used by subscribers of said wireless messaging system;

a message distribution system capable of allowing a subscriber of said wireless messaging system to review stored wireless messages sent to said subscriber comprising:

a first I/O interface capable of receiving a message retrieval request from said subscriber; and

a message retrieval controller coupled to said first I/O interface capable of determining an identity of said subscriber from identification data contained in said message retrieval request, retrieving a data record associated with said subscriber, said data record containing one or more of said stored wireless messages, and transferring to said subscriber one or more selected portions of at least one of said stored wireless messages; and

a database coupled to said message distribution system capable of storing said stored wireless messages.

11. The wireless messaging system set forth in Claim 10 wherein said message distribution system requires said subscriber to enter a password prior to transferring to said subscriber said one or more selected portions of said at least one of said stored wireless messages.

12. The wireless messaging system set forth in Claim 10 wherein said first I/O interface is capable of receiving a wireless message directed to said subscriber.

13. The wireless messaging system set forth in Claim 12 further comprising a second I/O interface capable of sending said received wireless message to an RF transceiver facility operable to transmit said received wireless message to a paging device of said subscriber.

14. The wireless messaging system set forth in Claim 12 further comprising an incoming wireless message controller capable of determining an identity of said subscriber from identification data contained in said received wireless message.

15. The wireless messaging system set forth in Claim 13 wherein said message distribution system is capable of receiving from said RF transceiver facility a response message responsive to a transmission of said received wireless message to said paging device.

16. The wireless messaging system set forth in Claim 10 wherein said message retrieval request is received from a public telephone system.

17. The message distribution system set forth in Claim 10 wherein said message retrieval request is received from a wide area data network.

18. For use in a wireless messaging system, a method for allowing a subscriber of the wireless messaging system to view on a display device stored wireless messages sent to the subscriber comprising the steps of:

receiving a message retrieval request from the subscriber;

determining an identity of the subscriber from identification data contained in the message retrieval request;

retrieving a data record associated with the subscriber, the data record containing one or more of the stored wireless messages sent to the subscriber; and

transferring to the subscriber one or more selected portions of at least one of the stored wireless messages.

19. The method set forth in Claim 18 including the further step of requiring the subscriber to enter a password prior to transferring to the subscriber the one or more selected portions of the at least one stored wireless messages.

20. The method set forth in Claim 18 including the further steps of:

receiving from the subscriber a complete message

retrieval request; and

in response thereto, transferring to the subscriber all of a selected one of the at least one stored wireless messages.

add E4

SYSTEM AND METHOD FOR RETRIEVING AND DISPLAYING PAGING MESSAGES

ABSTRACT OF THE DISCLOSURE

There is disclosed an improved message distribution system, for use in a wireless messaging system, that is capable of allowing a subscriber of the wireless messaging system to review stored wireless messages sent to the subscriber. The message distribution system comprises: 1) a first I/O interface capable of receiving a message retrieval request from the subscriber; and 2) a message retrieval controller coupled to the first I/O interface capable of determining an identity of the subscriber from identification data contained in the message retrieval request, retrieving a data record associated with the subscriber, the data record containing one or more of the stored wireless messages, and transferring to the subscriber one or more selected portions of at least one of the stored wireless messages.

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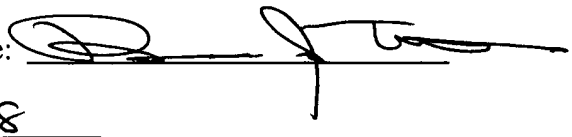
Atty. Docket No.: PAGE01-00136

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Full name of inventor: Richard J. Tett

Inventor's signature: 

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DOCKET NO. PAGE01-00136 **PATENT**

DECLARATION AND POWER OF ATTORNEY

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention, design or discovery entitled:

SYSTEM AND METHOD FOR RETRIEVING AND DISPLAYING PAGING MESSAGES

the specification of which is attached hereto.

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above;

I acknowledge the duty to disclose to the Office all information known to me to be material to the patentability of this application as defined by Title 37, Code of Federal Regulations, § 1.56.

I hereby claim no foreign priority benefits under 35 U.S.C. § 119 of any foreign application(s) for patent or inventor's certificate on which priority is claimed.

I hereby claim no benefit under 35 U.S.C. § 120 of any United States application(s) for patent. I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in § 1.56 which became available between the filing date of any prior application(s) and the national or PCT international filing date of this application.

I hereby appoint:

William A. Munck, Registration No. 39,308
John T. Mockler, Registration No. 39,775

of the firm of NOVAKOV, DAVIDSON & FLYNN, P.C. my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith, and to file and prosecute any international patent applications filed thereon before any international authorities under the Patent Cooperation Treaty.

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/136,839	08/20/98	340	2735	PAGE01-00136

APPLICANT

RICHARD J. TETT, PLANO, TX.

CONTINUING DOMESTIC DATA********
VERIFIED

None MJ

371 (NAT'L STAGE) DATA********
VERIFIED

None MJ

FOREIGN APPLICATIONS********
VERIFIED

None MJ

FOREIGN FILING LICENSE GRANTED 09/09/98

Foreign Priority claimed 35 USC 119 (a-d) conditions met / Verified and Acknowledged	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐yes ☒no ☐yes ☐no ☐Met after Allowance — MJ (Examiner's Initials) ____ (Initials)	TX	5	20	3

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TITLE

SYSTEM AND METHOD RETRIEVING AND DISPLAYING PAGING MESSAGES

FILING FEE RECEIVED	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT NO. _____ for the following:	
$790		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

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CONFIRMATION NO. 2211

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/136,839	08/20/1998 RULE	340	2635	PAGE01-00136

APPLICANTS

RICHARD J. TETT, PLANO, TX;

** CONTINUING DATA **********

** FOREIGN APPLICATIONS **********

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 09/09/1998

		STATE OR	SHEETS	TOTAL	INDEPENDENT
Foreign Priority claimed ☐ yes ☐ no 35 USC 119 (a-d) conditions met ☐ yes ☐ no ☐ Met after Allowance Verified and Acknowledged _____ Examiner's Signature Initials		COUNTRY TX	DRAWING 5	CLAIMS 20	CLAIMS 3

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SYSTEM AND METHOD RETRIEVING AND DISPLAYING PAGING MESSAGES

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APPLICATION NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET N
09/136,839	08/20/1998	340	2635	PAGE01-00136

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CONTINUING DOMESTIC DATA********
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371 (NAT'L STAGE) DATA********
VERIFIED

FOREIGN APPLICATIONS********
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Foreign priority claimed / 35 USC 119 (a-d) conditions met	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDE CLAIMS
O yes O no / O yes O no O Met after Allowance Verified and acknowledged _____ _____ Examiner's Name Initials	TX	5	20	3

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TITLE
SYSTEM AND METHOD RETRIEVING AND DISPLAYING PAGING MESSAGES

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

08/25/1998 DBUTLER 00000049 500302 09126839
01 FC:101 790.00 CH

PTO-1556
(5/87)

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 1997

Application or Docket Number: 136839

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)	SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE	FEE		RATE	FEE
BASIC FEE	[redacted]		[redacted]	395.00	OR	[redacted]	790.00
TOTAL CLAIMS	20 minus 20 =	* —	x$11=		OR	x$22=	
INDEPENDENT CLAIMS	3 minus 3 =	* —	x41=		OR	x82=	
MULTIPLE DEPENDENT CLAIM PRESENT			+135=		OR	+270=	
			TOTAL		OR	TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2

CLAIMS AS AMENDED - PART II

AMENDMENT A

	[redacted]	(Column 1) CLAIMS REMAINING AFTER AMENDMENT	[redacted]	(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total		* 20	Minus	** 20	= —
Independent		* 3	Minus	*** 3	= —
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
x$11=		OR	x$22=	—
x41=		OR	x82=	—
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	—

AMENDMENT B

	[redacted]	(Column 1) CLAIMS REMAINING AFTER AMENDMENT	[redacted]	(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total		* 20	Minus	** 20	=
Independent		* 3	Minus	*** 3	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
x$11=		OR	x$22=	
x41=		OR	x82=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	[redacted]	(Column 1) CLAIMS REMAINING AFTER AMENDMENT	[redacted]	(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total		*	Minus	**	=
Independent		*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
x$11=		OR	x$22=	
x41=		OR	x82=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

(10) 8/9/01

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2000

Application or Docket Number
09/136,839

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR (Filed And)	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	20 minus 20=	* 0
INDEPENDENT CLAIMS	3 minus 3 =	* 0
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	355.00	OR	BASIC FEE	710.00
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL		OR	TOTAL	Paid

E

CLAIMS AS AMENDED - PART II

AMENDMENT A	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 21	Minus	** 20	= 1
Independent	* 4	Minus	*** 3	= 1
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	18.00
X40=		OR	X80=	84.00
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Op amp 455b	Installed
Resistor 456f	1.21k ohms
Resistor 456e	Not installed
Resistor 456d	0 ohms
Resistor 456c	Not installed
JP5 1-2	shorted
JP7 2-3	shorted

For + 12 VDC output, the following configuration may be used:

XOR gate 454b	Installed
XOR gate 454c	Installed
Op amp 455b	Installed
Resistor 456f	1.21k ohms
Resistor 456e	Not installed
Resistor 456d	10k ohms

Resistor 456c	7.15k ohms
JP5 1-2	shorted
JP7 2-3	shorted

For RS-232 levels, the following configuration may be used:

Inverter 457	Installed
Resistor 456f	Not installed
Resistor 456e	Not installed
Resistor 456d	Not installed
Resistor 456c	Not installed
JP5 1-2	shorted
JP7 2-3	shorted

The microprocessor UART has three configuration registers associated with it plus one status register and one data register. The configuration registers should be setup as follows:

All bits of register SCCRI ($x02C) are 0 for most applications.

In register SCCRI ($x02D), bits 7-2 for interrupts and enables should be set as desired; bit 1 should be 0 for normal operation; and bit 0 should be 0 for normal operation. In register BAUD ($x02B), bit 5 should be 1 and bit 4 should be 0 for master divider. Bits 2 to 0 can be configured for the following baud rates:

Baud	Bits 2:0
38400	0 0 0
19200	0 0 1
9600	0 1 0
4800	0 1 1
2400	1 0 0
1200	1 0 1
300	1 1 1

Data to be sent can be written to register SCDR $x02F when bit 7 (TDRE) of SCSR ($x02E) is a 1, indicating that the transmitter is ready to accept more data. When SCSR bit 5 (RDRF) is a 1, it means that a received character is ready to be read from SCDR.

SCDR has alternate functions for read and write.

Data port 452, which in a preferred embodiment is configured for radio communication, appears at physical connector J3 on the CPU board as shown in Figure 6. The connector itself is a three pin locking polarized Molex style connector with pins on 0.1 inch centers. Three lines are supported: TXD, RXD and GND.

The interface of data port (452) can be independently configured for +5VDC/0V levels with data inverted or not inverted (invert/non-invert decision is under software control), +12VDC/0V levels with data inverted or not inverted, or real RS-232 levels with non-inverted data only. The invert/not invert decision is handled by asserting or de-asserting an output pin on the DUART (441) with one pin dedicated to each channel (pins are labeled POLSW2 and POLSW4). For a single channel, transmit and receive invert as well as transmit and receive voltage levels are independent. The actual output voltage, +5VDC or +12VDC or something between, is set by the resistors associated with each operational amplifier in each transmit path.

If POLSW2 is low, then the data transmitted out data port (452) is not inverted. If POLSW2 is high, then the data transmitted out data port (452) is inverted. If POLSW4 is low, then the data received (with non-RS-232 levels) at data port (452) is not inverted. If POLSW4 is high, then the data received at data port

(452) is inverted. The POLSWX lines will need to be initialized at startup before any data is sent out either data port (451) or data port (452).

The logical side of data port (452) connects to Port B on the DUART (441), which is a 68681. The DUART port has some advantages over conventional UARTS. The DUART clock is driven by a separate crystal for the DUART which makes it independent of the processor crystal/clock. The port supports baud rates from 50 baud to 115200 baud. To reduce interrupt traffic when running high speed data, the port has a four byte receive buffer and a two byte transmit buffer. It supports character lengths from 5 to 8 bits and parity. It can be set to interrupt the processor when there is one character in the buffer or when the buffer is full (four characters). Although interrupt sources are selectable in the DUART, there is only one interrupt line from the DUART to the processor on IRQ. The software must sort through possible interrupt sources while in the IRQ routine to determine who caused the interrupt.

Data port (452) will typically be used to communicate with an ADEMCO (TM) radio and will be configured to operate at +12VDC levels. For +5VDC output, the following configuration may be used:

XOR gate 454a Installed

XOR gate 454d	Installed
Op amp 455a	Installed
Resistor 456h	1.21k ohms
Resistor 456g	Not installed
Resistor 456b	0 ohms
Resistor 456a	Not installed
JP6 1-2	shorted
JP8 2-3	shorted

For + 12 VDC output, the following configuration may be used:

XOR gate 454a	Installed
XOR gate 454d	Installed
Op amp 455b	Installed
Resistor 456h	1.21k ohms
Resistor 456g	Not installed

Resistor 456b	10k ohms
Resistor 456a	7.15k ohms
JP6 1-2	shorted
JP8 2-3	shorted

For RS-232 levels, the following configuration may be used:

Inverter 457	Installed
Resistor 456h	Not installed
Resistor 456g	Not installed
Resistor 456b	Not installed
Resistor 456a	Not installed
JP6 1-2	shorted
JP8 2-3	shorted

In a preferred embodiment, data port (453) is configured as a PC compatible 9-pin male D-sub at RS-232 levels with all lines supported, as shown in Figure 7. The connector is a straight up

plastic shell type located on the CPU board. The logical side of data port 453 connects to Port A on the DUART (441).

Data port (453) is configured as a DTE (data terminal equipment) exactly the same as a PC serial port. The software should cause the port to behave like a PC serial port. Common definitions are as follows:

Pin	Name	TTL voltage level	Comments
1	DCD - Data Carrier Detect	Read 0V when carrier detected	Input to system from external modem to indicate that another data modem is online and connected
2	RXD - Receive Data	Read +5V when idle	Input to system from external modem
3	TXD - Transmit Data	Set to +5V when idle	Output from system to external modem
4	DTR - Data Terminal Ready	Set to 0V when ready	Output from system to external modem to indicate system is powered; usually paired

			with DSR
5	GND - Ground		
6	DSR - Data Set Ready	Read 0V when modem ready	Input to system from external modem to indicated external modem is powered; usually paired with DTR
7	RTS - Request to Send	Set to 0V to request	Output from system to external modem that is the hardware handshake line to control the modem's transmit data
8	CTS - Clear to Send	Read 0V when modem ready	Input to system from external modem that is the hardware handshake line to allow external modem to control system's transmit data
9	RI - Ring Indicator	Read 0V when ring detected	Input to system from external modem to indicate that the modem

is being called or
receiving data transfer
initiation information
at its correct address

Data port (454) handshake lines consist of a number of inputs and outputs which are connected to the DUART I/O ports. DUART input state can be determined by reading the DUART register INPUTP ($x06D). The register exactly reflects the state of the input, so if the DUART input pin is +5VDC then the bit location associated with that input will read as a 1. Data port (453) CTS is read on bit 0, DSR is read on bit 1, RI is read on bit 2 and DCD is read on bit 3.

The following illustrates a quick setup/usage example for the DUART.

The following sequence should be performed to initialize both DUART ports for 9600 baud, 8 bits and 1 stop bit:

	Store $70 to ACR ($x064)	This sets the baud rate generator to derive its clock from the crystal frequency of).6864MHz divided by 16.
20	Store $BB to CSRA ($x061) and to CSRB	This sets the baud rates for both channels to 9600 baud.

($x069)

Store $1A to CRA ($x062)	This resets the MR pointer so the next write is to MR1A.
Store $13 to MR1A ($x060)	This sets the parity to none and number of bits to 8 for DUART channel A.
Store $07 to MR2A ($x060)	A write to MR2A must always and only follow a write to MR1A. This sets the channel mode to normal and stop bit length to 1.
Store $1 A to CRB ($x06A)	This resets the MR pointer so the next write is to MR1A.
Store $13 to MR1 ($x068)	This sets the parity to none and number of bits to 8 for DUART channel B.
Store $07 to MR2B ($x068)	A write to MR2B must always and only follow a write to MR1B. This sets the channel mode to normal and stop bit length to 1.

Store $05 to CRA	This enables the DUART A channel transmitter and receiver.
Store $05 to CRB	This enables the DUART B channel transmitter and receiver.

The DUART register structure resembles any other serial subsystem. A status register can be read until a particular bit indicates that the transmitter is ready to accept another character to be sent. Then the bit is loaded into that register and the hardware handles the transmission. For Port A, register SRA ($x061) bit 2 (TXRDY) can be read and if it is a 1 this indicates that the next character to be transmitted can be loaded to THRA ($x063). For Port B, register SRB ($x069) bit 2 (TXRDY) can be read and if it is a 1 this indicates that the next character to be transmitted can be loaded to THRB ($x06B).

The DUART receive operates as follows. A bit in a register can be read to determine if a valid character has been received. Then a separate character register can be read to retrieve the data and this process automatically clears the character ready bit. For Port A, register SRA bit 0 (PXRDY) can be read and if it is a 1 this indicates that a character is ready to be read from RHRA ($x063). For Port B, register SRB bit 0 (RXRDY) can be read and if it is a 1 this indicates that a character is ready to be read from RHRB ($x06B).

As is shown in Figure 4, located on the CPU are LEDs (425a-d), all under microprocessor control. The LEDs can be used as status indicators. LEDs (425a-c) are driven through a buffer from PA3, PA4 and PA5 on the microprocessor 410. The PA pins must be configured as outputs in order to control the LEDs. The pins should also be directly under control of the software, so none of the internal processor timers should be setup to be associated with the driving pins on this port. The LEDs are driven by sinking the current, so to turn one of these LEDs on, a one (+5VDC level) must be written to the appropriate output pin. The LEDs are low current (4mA) types which can be directly driven from an HCMOS output sinking current.

LED (425d) is driven from output pin OP2 of the DUART 441. Once the DUART is configured, writing two DUART internal registers, Set Output Port Bits ($x06E) and Reset Output Port Bits ($x06F) causes the output port pin to change state. These registers function much like a flip flop. Writing a "1" to a bit position in the Set Output Port Bits register will cause that bit position in the DUART internal OCR (output control register) to be a ▒1▒, in turn making that output pin a "0" or low voltage. Writing a ▒1" to a bit position in the Reset Output Port Bits register will cause that bit position in the DUART internal OCR to be a "0", in turn making that output pin a "1" or high voltage. Note the inversion from the commanded Set/Reset to the actual state of the

output pin.

As shown in Figure 3, the CPU board gets power through the power connector (426) at J1. It is a male 10-pin dual row right angle header that carries the +5VDC line, the +12VDC line and VUNREG (pre-regulated input) to the CPU. The power supply should not be powered as the CPU and power supply board are engaged because there is no physical pin configuration that sets power up sequence. Plugging the CPU into a live power supply runs the risk of latch up or other power up problems.

The low voltage AC power supply (600) interfaces directly to the CPU board (410) and provide power to the CPU over an interface connector. Additionally, the power supply (600) provides external power for outboard devices such as a dial up modem and radio modem.

The low voltage AC power supply board (600) circuitry may be constructed on a circuit board dimensioned as 3.94 inches by 3 inches and constructed of FR-4 laminate with a finished thickness of 0.062 inches and rated UL 94V-0 for flammability. It is a two layer circuit board with blue solder mask on both sides and white silkscreen on the component side. Component symbols and hole sizes on the board have been designed to be easily hand manufacturable. Component holes have been placed on a standard grid to allow for inexpensive fabrication of a board test

fixture.

As is shown in Figure 8, the power supply (600) is designed to be powered by an AC input voltage, but can also be used with DC under appropriate circumstances. Input power is supplied by a UL/CSA recognized external step down transformer that would convert the 117VAC rms line voltage to the voltage necessary to derive the required DC output voltage. For example, when the variable high current supply is set at +12VDC for an output current of 2A, then the AC input required is 16.5 VAC rms. Other AC input DC output combinations are possible and can be accommodated on an individual application basis. The actual AC input terminals are located on J2 and are both labeled AC.

Four diodes, (601-604), rated at 3A are used in a bridge configuration at the input. The bridge configuration allows the use of an external step-down transformer without a center tap. Also, since the bridge is a full wave rectifier, a smaller filter capacitor can be used despite the high output current. Etch placed directly under the diodes as part of a limited ground plane on the component side also serves as a heat sink. The forward drop across each of the diodes when running their full rated current is 1.1 VDC.

A large aluminum electrolytic filter capacitor (605) is used on the supply input in order to smooth the rectified DC to maintain

a proper voltage into the regulators at maximum current draw. When the variable output is set to +12VDC, it is necessary to maintain a minimum voltage into the regulator of +14VDC. With a 3300uF capacitor rated at 50VDC for the main filter, at the maximum load of 2A this yields a ripple of 5VDC. This dictates that the input to the filter must be at least 19VDC at peak. The ripple and thus the input voltage could be reduced at the expense of increasing the input filter capacitor substantially in size and cost.

The capacitor selected as filter must also be designed to withstand the heating effects of current surging through it and still operate to the product's designed lifetime. The amount of heat generated is determined by the capacitor's equivalent series resistance. A related parameter is the capacitor manufacturer's specified ripple current rating at a particular temperature. A capacitor with a ripple rating of greater than 2.5A at 85 degrees C is necessary in this design. If the capacitor is operated at higher than its rated ripple voltage at a specified temperature for a long period of time, the heat generated in the capacitor will cause the electrolyte in the capacitor to evaporate, the capacitor will fail, and soon after the product will fail.

The +5VDC regulated output voltage is set by a fixed three terminal 7805 TO-220 packaged regulator (606). The regulator is heat sinked so it will operate properly with an approximate

maximum draw of 700 mA while keeping the 7805 junction temperature below 70 degrees C, which is well below its maximum 125 degree C rating. In addition, all 7805 regulators have a built in thermal shut down so if the regulator becomes too hot due to a circuit failure, it will cease to supply current until it cools down.

The variable output supply is set by resistors 607 and 608 and adjustable regulator (609), which can be configured to provide output over a wide range, with the output typically set at +12VDC. The supply is designed to deliver a fixed voltage at high current to an external device, such as an RF modem. The device is heatsinked to allow a maximum constant current draw of 2A without the device overheating. At 2A draw, the junction temperature on the regulator is acceptable at about 70 degrees C, well below the 125 degrees C limit. Power is delivered both to the CPU board to be used in some analog circuitry and to an external device, such as a modem, through the screw terminal block at J3.

A small power line filter has been constructed on the board using discrete components 610-613. This low pass filter reduces the ability of power line noise to get into the supply and ultimately cause operational problems at the CPU. Also, this filter helps to reduce the amount of CPU generated noise that passes through the power supply and would be conducted onto the AC line. CPU

generated power line noise must be kept to a minimum in order to meet FCC conducted emissions requirements for digital devices.

The third terminal on the J2 block on the board is the EGND (Earth ground) terminal 614, which is designed to accommodate a connection to green wire ground from the local AC distribution system. EGND can be connected to circuit ground by populating the 615 resistor location with a zero ohm resistor. EGND is a convenient place for the input filter to dump noise energy and should be wired to keep the system operating reliably.

AC power is supplied from an external transformer to the AC inputs at the screw down terminal block at J2. The connector that connects the supply to the CPU is a 10-position two-row 0.1 inch spaced 0.025 inch pin socket. It provides a positive locking feel when the supply board and CPU engage properly. It is designed to allow the boards to slide together easily along track or card guides.

As is shown in Figure 4, the CPU (400) has an expansion connector (435) designed to accommodate I/O devices such as discrete inputs and outputs, a real time clock, as well as A/D converters, D/A converters and their necessary conditioning circuitry. In particular, the expansion connector is an interface between the SPI bus (413) of the microprocessor (410) and the input board (310).

The expansion connector extends the system +5VDC supply at relatively high current capability (hundreds of mA) and +12VDC at low current (tens of mA). The +5VDC line can power logic on the expansion board and the +12VDC line can be used as an analog supply, possibly to bias operational amplifiers for signal conditioning. A common ground return is also presented at the connector. Resistors (436a and 436b) can be populated with current limiting resistors in order to protect the CPU board power from drastic failures on an expansion board.

The expansion connector (435) supports a buffered SPI bus interface (413) driven directly from the processor. The SPI bus is a processor based synchronous data bus with one send data line, one receive data line and one processor driven clock line. It can interface to multiple SPI bus peripherals on the expansion card if a separate output line is used as a select line for each SPI device. Typical peripheral devices that support a SPI bus interface include EEPROMS, A/D converters, D/A converters, real time clocks and general purpose I/O devices.

Expansion connector (435) supports six discrete signal lines, four outputs and two inputs. The outputs are driven from PG0 to PG4 directly off the processor and HCMOS buffered. They have no timers associated with them on the CPU and would typically be used as select lines for external SPI bus peripherals or to

implement a small number of outputs with no intervening select or multiplex chips. The inputs are HCMOS buffered after they arrive on the CPU board and then drive PA0 and PA1 processor input lines directly. PA0 and PA1 can be configured as general purpose inputs or inputs that generate interrupts on rising or falling edges. They can be left unterminated as they are pulled up on the CPU board.

In a preferred embodiment, the input board (310) supports points that connect directly to line voltage, so it is important to select devices that provide appropriate isolation. In a preferred embodiment, optocouplers (202) are used because they provide more than adequate protection (typically greater than 2500VAC) and are small in size, low cost and available from a number of vendors.

In any monitoring application, the main concern (beyond safety) is the ability to actually read the input status. A preferred optocoupler, the H11AA1, has back to back LEDs internally to detect both the positive and negative going transitions of the AC wave. Current limiting resistors (203) and (204) are used in series with the optocouplers (202) to limit the current through the diodes. In a preferred embodiment, resistors (203) and (204) are half watt resistors sized so that the nominal LED current is reached at about 70V. The "always on" synch input (201) has slightly larger resistors so it will turn on slightly after the

other inputs. By sampling the inputs slightly after the synch input triggers, the AC voltage will be read at its peak and the proper AC voltage status will be read. Using this scheme, the resistors are large so they do not dissipate much heat. Because they are not dissipating much heat, making them half watt type affords a large safety margin.

The expansion connector (435) is a 14-position Molex Mini-Fit style with locking tabs to allow it to easily pass through the wave soldering process without the need to add mounting hardware. It is mounted in the center of the board with minimum runs to the high side of the optocouplers. It has been optimally placed on the board with optocouplers around it to isolate the AC line voltage carrying etch to an area bounded by an imaginary line drawn through the center of each optocoupler.

The pinout for the 14-pin connector is as follows:

Pin Number	Signal
1	120 VAC Input 1
2	120 VAC Input 2
3	120 VAC Input 3
4	120 VAC Input 4

5	120 VAC Input 5
6	120 VAC Input 6
7	120 VAC Hot
8	120 VAC Input 7
9	120 VAC Input 8
10	120 VAC Input 9
11	120 VAC Input 10
12	120 VAC Input 11
13	120 VAC Input 12
14	120 VAC Neutral

The synchronous reference input is at pin number 7 on the AC interface connector and is required to be wired to a 120VAC hot line in the machine which is always powered. This line provides a reference edge a predictable distance from the zero crossing which is the signal for the processor to read all the inputs. This input is sensed, squared, and divided by circuitry on the AC

input board. J1 is the jumper header that allows the interrupt rate to be selected. The minimum hardware configurable setting, for interrupt rate is 16.6 Hz with J1-1 and J1-2 shorted. Next follows 33.2 Hz for J1-3 and J1-4 shorted and so on up to a sample every 2.2 seconds with J1-15 and J1-16 shorted. Additional edge can be added using resistor 206 and capacitor 207 as necessary with the resulting signal appearing on the microprocessor's PA0 input. The microprocessor should be setup to interrupt and sample on the signal's falling edge.

Point data for the input card is read over the processor's SPI bus (413) when the read data interrupt signals that a read should occur. The AC point status information is conditioned on the AC card and appears at 74HC165 parallel to serial converters (208 and 209). These devices will send data present at their inputs out a single serial data line in synchronization with the processor issued clock. However, because these devices are not tristate so will not share the bus with other devices, 74HC126 tristate devices (210 and 211) are added. Since in the preferred embodiment the board has 12 inputs (8+4), they are supported on two serial parallel chips and two gates on the tristate device. To read point data from the first eight points, processor line PG0 would be driven high from its normally low state and the SPI subsystem (413) could shift out a dummy byte. The byte read in during the shift would represent the status of the AC inputs. Then the PG0 line would be returned to its normally low state.

To read the next four inputs, the PG1 line would be driven high from its normally low state and the SPI subsystem (413) could shift out a dummy byte. These four inputs would be read back as bits 0-3 of the returning byte; bits 4-7 should always read back as zero since they are grounded on the input to the parallel to serial converter (209). Then the PG1 could be returned to its normally low state.

Note that the above prototype is independent of the original vending machine type (requiring only that it contain components suitable for use as monitoring points) and of network type. Although modifications might be required to conform to specific network protocols, the serial interfaces to the vending machine are fixed, and the data collected and transmitted is independent of network or machine considerations.

THIRD PREFERRED EMBODIMENT - PROTOTYPE OF SPACE TO SALES

The following prototype was constructed to highlight and demonstrate the scheduling features of the invention.

Referring to Figure 12(a), a vending machine is selected for scheduling (4000), said vending machine comprising at least one supply column for holding a supply of at least one product, and at least one selection button. User parameters with respect to

the selected machine are obtained and stored (4010), preferably in computer-readable format, including a minimum threshhold and maximum product capacity, and the number of vending columns in said machine and the capacity of each of said columns; product codes and the associated product names may also be stored (4020) for use in report or display generation. For the particular time, a vender load record is obtained (4030) for each machine to be scheduled. An array of the vending columns and capacities and products is created (4040), preferably using microprocessor means accessing computer-readable data. The velocity of each product is calculated (4050), preferably using microprocessor means, as the rate of vends per day, preferably to two decimal places. Vender products are validated against the user parameters (4060) which set limits for a maximum number of products and minimum velocity, and the array is adjusted accordingly, if necessary. A work array is then created (4070) comprising vender's columns and the products currently assigned to those columns, and two dummy columns are added with zero capacity for each product.

Referring to Figure 12(b), a capacity is then calculated for each product (4080) by allocating total vending machine capacity among products in proportion to the ratio of each product's velocity to the total vending machine velocity.

The capacity is adjusted by an iterative process, the goal of which is to minimize the value of the sum of the squares of the

difference between product column capacity and optimum column capacity ("FIT"). FIT is first calculated for the then-current configuration of products to columns (4090). Two columns containing different products are then selected and exchanged and a new value of FIT calculated (4100). The new value of FIT is compared with the old value of FIT (4110). If the value has decreased, the new configuration is used as the new "then-current" configuration (4120); if the value has not decreased, the original configuration is retained as the "then-current" configuration (4130). The process is repeated until the smallest value of FIT is found (4140).

Referring to Figure 12(c), a determination is next made whether the then-current configuration associated with the minimum value of FIT extends the service period (4150); if not, the initial configuration is retained and a new vending machine is selected for evaluation (4160). Otherwise, a recommendation is made to reconfigure the vending machine (4170), which reconfiguration may be accomplished by service personnel during the next visit, and a new vending machine is again selected for evaluation until all vending machines have been evaluated. Optionally, the effects of the changes on operations, such as savings in cost, may be captured and reported.

The preferred embodiment of the process is a microprocessor with hard disk for storing user parameters. A computer program

suitable for carrying out the above process is attached as Appendix A, and reference is made thereto for additional details of operation.

In three experiments conducted using the above prototype on actual sales locations, improvements of 56.3%, 84.2% and 118.7% were recorded.

While specific embodiments of the invention has been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles and that various modifications, alternate constructions, and equivalents will occur to those skilled in the art given the benefit of this disclosure. Thus, the invention is not limited to the specific embodiment described herein, but is defined by the appended claims.